OPERATION MANUAL

CE-30C
DIGITAL
dB METER

CUSHMAN
ELECTRONICS, INC.

MP MASTER
MA31786

CE-30C
DIGITAL
DB METER

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October 1972

WARRANTY

CUSHMAN ELECTRONICS, INC. WARRANTS EACH OF THE INSTRUMENTS OF THEIR MANUFACTURE TO BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM THE DATE OF ORIGINAL PURCHASE. THE FOREGOING IS IN LIEU OF ANY OTHER WARRANTY, EXPRESS, IMPLIED OR STATUTORY. THE COMPANY, UNDER THEIR LIBERAL WARRANTY, WILL REPAIR OR REPLACE ANY INSTRUMENT FOUND DEFECTIVE.

THIS WARRANTY MAY NOT APPLY TO INSTRUMENTS WHICH, IN THE OPINION OF THE COMPANY, HAVE BEEN ALTERED OR MISUSED.

This manual is intended to give the user a comprehensive knowledge of the instrument and its operation or repair. In the event of trouble, study the manual carefully. Most instrument malfunctions can be corrected by the user with a minimum of lost usage time.

For assistance or information of any kind, contact the factory. Give full details of the nature of your problem and include the model and serial number of the instrument.

Should it appear that the instrument needs to be returned to the factory for service or recalibration, let us know. Shipping instructions will be promptly given to you. There will be no charge for repair on instruments within the one year warranty other than transportation costs after 90 days of ownership. Estimates of charges for non-warranty or any other service will be supplied by the factory upon request before work is begun and such work will be done on an actual cost basis only.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

* * * * * *

We sincerely pledge our immediate and fullest cooperation to all users of our precision electronic instruments.

PLEASE ADVISE US IF WE CAN ASSIST YOU IN ANY MANNER

CUSHMAN ELECTRONICS, INC.

830 Stewart Dr. ☐ Sunnyvale, Cal. 94086 ☐ 408—739-6760

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CE-30C
DIGITAL DB METER

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1. GENERAL

DESCRIPTION

1.01 The CE-30C Digital dB meter is a compact, lightweight instrument, with a remote digital display, particularly designed for mounting in the rear of portable test consoles or local test desks. The remote digital display is to be mounted in the front panel of a portable console or a test desk.

1.02 It is used for highly accurate message, data and program channel measurements. Power levels from -50.2 to +12.2 dBm and noise from 0 to 60.2 dBrn are measured with automatic ranging. It is provided with a C-message weighting filter for noise measurements, the noise averaging period being 375 ms. Frequency range is from 50 Hz to 50 kHz, and input impedance is 900Ω. The CE-30C is calibrated to read directly in dBm in the level mode and in dBrn in the noise mode using the C-message filter.

1.03 In the Noise mode, quasi-rms detection gives accurate power readings with either sine waves or white noise input with crest factors of up to 12 dB (4:1 peak to rms ratio). In the Level mode average detection is used so that average power readings are displayed.

1.04 The CE-30C receives its power from the Central Office 48V battery.

1.05 Specifications for the instrument are listed in Table A.

ACCESSORIES

1.06 The following items are supplied with each instrument:

1 - 12 inch extension cable with 15 pin connectors on each end

1 - Mounting bracket for one end of the extension cable

1 - 9 pin input connector with 20 inch color coded wires attached

1 - Non-glare, neutral, circular polarizer display filter

1 - Instruction Manual

2. INSTALLATION

UNPACKING AND INSPECTION

2.01 When unpacking the CE-30C inspect the packing box and the instrument for signs of possible damage. Verify satisfactory performance as outlined in the operating instructions (Section 3) of the instrument manual. If the instrument is damaged, or fails to operate properly, file a claim with the transportation agency or, if insured separately, with the insurance company.

CONNECTIONS

2.02 Power for the instrument is taken from the CO 48V battery. Connect wires from the

Table A. Specifications

ITEM	CHARACTERISTICS
FREQUENCY	
Range	50 Hz to 50 kHz
POWER MEASUREMENT	
Resolution	
Level Mode	0.1 dBm
Noise Mode	0.1 dBrn
Ranges	
Level Mode	-50.2 dBm to +12.2 dBm
Noise Mode (C-message)	+0 dBrn to +60.2 dBrn
Accuracy	
Level Mode	±0.1 dBm (±0.2 dBm 50 Hz to 100 Hz and 30 kHz to 50 kHz)
Noise Mode (C-Message)	±1.0 dBrn between 5.0 and 60.2 dBrn ±2.0 dBrn between 0 and 5.0 dBrn
Input Crest Factor (peak/rms)	12 dB (4:1) maximum
Temperature Coefficient	±0.002 dB per C° from 0° to 50°C
Noise Averaging Period	375 MS
Input DC Settling Time	1 SEC max per ±20V DC input step function
Auto Range Delay (per Range, 6 Ranges Max)	
Level Mode	275 MS ±60 MS
Noise Mode	375 MS ±40 MS
Read Rate	
Level Mode	50 readings per sec
Noise Mode	2.5 readings per sec
DISPLAY (Remote; mounted on PC Board with 15 pin double readout edge connector. 1.35" h x 2.5" w)	One segmented polarity LED 1/4" h Three 7-segment numeric LED's 1/4" high with decimal point
Connector	Amphenol 15 pin P/N 17-10150
INPUT	
Impedance (return loss)	900Ω ±0.1% (≥ 46 dB)
Common mode (longitudinal voltage) Rejection	70 dB from 50 Hz to 300 Hz 60 dB from 300 Hz to 10 kHz 50 dB from 10 kHz to 50 kHz
Protection (maximum permissible voltages)	
Metallic (tip to ring)	±150V DC continuous
Longitudinal (tip and ring to sleeve)	±600V DC continuous
HOLD CURRENT	33 to 50mA with 48V CO battery
REMOTE INPUT	
Connector	Amphenol 9 Pin P/N 17-80090
Inputs	Pin 1. -48V DC (switched externally Pin 2. * Common Pin 3. N/C Pin 4. Sleeve Pin 5. Ring input Pin 6. N/C Pin 7. *Select C Pin 8. N/C Pin 9. Tip input
*Note: Connect Pin 7 to Pin 2 through a remote switch to switch the CE-30C from the "Level" mode to the "Noise-C message" mode.	

Table A. Specifications (continued)

ITEM	CHARACTERISTICS
OPERATING TEMPERATURE	0°C to 50°C
POWER REQUIREMENTS DC	-45 to -55V DC 150 mA
DIMENSIONS	2-9/16" h x 8-3/4" w x 10-45/64" d
WEIGHT	6 lbs.

Input connector as follows:

Red (pin 1) to -48VDC (externally switched)
Black (pin 2) to Battery Common

2.03 For the signal Input, connect wires from the Input connector as follows:

Green (2 wires) (pins 5 and 9) to Ring and Tip
Yellow (pin 4) to Sleeve

CAUTION

Do not allow the White wire to short to the Red wire. Serious damage will result if they touch.

2.04 To select the Noise mode, connect the white wire (pin 7) through a remote switch back to battery common, black wire (pin 2). When the switch is closed the instrument will be switched to the Noise-C message mode.

2.05 Mount the Remote Indicator in the Test Panel. The L.E.D. display board plugs into the jack with the LEDs toward the side marked FRONT. Connect both plugs to the CE-30C.

POWER REQUIREMENTS

2.06 The instrument draws 150 mA from the 48V supply and is protected by a 1/4A slo-blo fuse which is mounted on the rear panel. An external switch must be provided to control the 48 VDC to the CE-30C.

2.07 There are no warmup requirements for the CE-30C. When power is connected to the instrument it is ready to operate.

PREPARATION FOR RESHIPMENT

2.08 It is recommended that the shipping box and foam packaging be kept in case it becomes necessary to ship the instrument to the service point or factory for service or repair. (Contact Cushman Electronics Customer Service Department before returning an instrument.)

2.09 The following is a general guide for repackaging the instrument for shipment.

NOTE

If the instrument is to be shipped, attach a tag identifying the owner and indicate the service or repair to be accomplished. Include the model number and full serial number. In any correspondence, always identify the instrument by model number and serial number.

2.10 If the original container is to be used, proceed as follows:

(1) Place the instrument in the original container. (If the original container is not available, one can be purchased from Cushman Electronics.)

(2) Make sure that the container is well sealed with strong tape.

2.11 If the original container is not used, proceed as follows:

(1) Wrap the instrument in plastic or heavy paper before placing in an inner container.

(2) Place packing material around all sides of the instrument.

(3) Place the instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

(4) Mark the shipping container: "DELICATE ELECTRONIC INSTRUMENT", "FRAGILE".

SERVICE OR REPAIR

2.12 In the event that factory service or repair seems to be required, contact the Cushman Electronics Customer Service Department for further service information or to make arrangements for shipment to the factory or to a Service Center. The factory address is:

Cushman Electronics, Inc.
Customer Service Department
830 Stewart Drive
Sunnyvale, California 94086
Telephone: (408) 739-6760

2.13 The service point for the CE-30C in the southeastern U.S. is:

BCS Associates, Inc.
940 North Fern Avenue
Orlando, Florida 32803
Telephone: (305) 843-1510

3. OPERATION

3.01 The CE-30C is designed to be mounted in a portable Console or a Test Desk. After the proper connections have been made, according to paragraphs 2.02, 2.03, 2.04, 2.05, level or noise measurements will be made according to the procedures of the equipment in which the CE-30C is installed.

4. THEORY OF OPERATION

GENERAL

4.01 The overall block diagram (figure 1) shows the interconnections of the various circuit elements and indicates the signal flow through them. Three printed circuit boards are shown on the block diagram; the analog board, the digital board, and the readout board. The bold four-digit-numbers shown on the diagram are Circuit Reference Series numbers, which are used to identify specific boards. Throughout this manual, the text, schematic, and parts list applicable to a specific board, are all prominently marked with the same numbers. The boards are described in the order in which the circuits on them are in the signal path.

4.02 The Circuit Reference Series is also used as a quick means to locate a circuit element. For instance, when reference is made to Q2101, this transistor can be found by turning to the schematic marked 2100 and finding Q1 on that schematic. Similarly, the type, value, and tolerance of this transistor can be found by turning to the parts list marked 2100 and finding Q1.

FUNCTIONAL DESCRIPTION

4.03 The CE-30C is designed to measure power levels from -50.2 to +12.2 dBm for frequencies ranging from 50 Hz to 50 kHz. The instrument also measures noise levels from 0 to +60.2 dBrn with a C-message bandwidth.

4.04 The input signal is applied to J2305 and fed through part of the digital board (2300), where an input impedance of 900 ohms is provided. The signal is then fed to the analog board (2100) for conversion to a DC voltage proportional to the RMS or average value of the input waveform. The signal is then returned to board 2300, where the A/D conversion is made.

4.05 On the digital board, the analog voltage is converted to digital pulses, is counted and is decoded for display. The decade within which the input signal falls is determined by the automatic ranging circuits, which preset the tens decade of the display counter to the appropriate digit. The units and tenths digits are counted by the display counter.

4.06 The count is stored in the display storage and then fed to the readout multiplex logic and the display driver, which decodes the binary information and feeds it to the readout board (2200) for display. After the levels are digitized and stored, the counter is automatically reset and a new reading begins.

4.07 The timing of the CE-30C operation is controlled by frequencies derived from a 200 kHz oscillator on board 2300.

CIRCUIT DESCRIPTION

4.08 ANALOG BOARD, 2100

4.09 The input signal is connected to the 16 dB balanced attenuator, and the output of the attenuator drives the input amplifier which has +16 dB gain.

4.10 The input amplifier consists of transistors Q2122, Q2123, Q2124, Q2125 plus amplifier IC2103 and associated resistors. Diodes CR-2108, CR2109, CR2110 and CR2111 provide input protection from high voltage. The four transistors form two darlington emitter followers. The followers isolate the low input impedance of the input bridge differential amplifier, IC2103, from the input attenuators. This amplifier receives a differential input and produces a single ended output.

4.11 The output signal of amplifier IC2103, when the remote switch is in the Level position, flows to the "variable gain amplifier A" (-10, 0, +10 dB). The "variable gain amplifier A" drives the "variable gain amplifier B" (0, +10, +20, +30 dB). These variable gain stages are used for automatic ranging, which will be described later. The gain amplifier B output signal flows to the input of the Average or Quasi RMS AC/DC Converter.

4.12 The Average or Quasi RMS AC/DC Converter produces a DC output voltage proportional to the RMS value of an input waveform of either sine wave or white noise when the instrument is in the noise mode, or an output proportional to the average value of these waveforms in the level mode. As a Quasi RMS detector (noise mode) the collector current of transistor Q2128 is proportional to the average current in resistor R2162 plus a portion of the peak current in resistor R2172. R2168 is not in the circuit at this time. As an average detector (level mode) R2172 is switched out of the circuit and R2168 is switched in to replace R2173. The collector current in Q2128 is now proportional only to the average current in R2162, also the gain of Q2128 is adjusted to compensate for the different type of detection. The AC/DC Converter is followed by an active, three-pole Butterworth filter to remove the ripple.

4.13 In the noise mode the output of IC2103 is connected to the input of the 30 dB gain amplifier instead of the variable gain A circuits. The output of this amplifier flows to the filter circuit, which contains a passive filter with a midband insertion loss of 6 dB. The output of the filter is connected into the 16 dB gain amplifier from which the output is connected to the variable gain amplifier A. The signal flow then continues as described before.

4.14 The output from the analog board, "scaling amp output", drives the UP range detector, and the A/D converter and DN range detector on the digital board (2300).

4.15 DIGITAL BOARD. 2300

4.16 10 Volt Reference

4.17 The 10 volt reference supply uses diodes CR2301, CR2302, and resistor R2311 to form a starting circuit to ensure a positive output voltage. After the circuit is operating, diode CR2302 becomes reverse biased disabling the startup circuit. Amplifier IC2313 has a potentiometric gain of approximately X1.6 which amplifies the 6.2 volts of zener diode CR2303 to 10 volts. Resistor R2317 is used to adjust the gain of the amplifier so that the voltage output is 10 volts. This 10 volts is used as a reference for both the UP range detector, A/D converter and DN range detector.

4.18 Automatic Ranging.

4.19 Automatic ranging is accomplished in six 10 dB steps. The scaling amplifier output voltage from the analog board, within each 10 dB step, varies between 3.162 volts and 10.000 volts. A voltage less than 3.162 or greater than 10.000 volts indicates a signal below or above the 10 dB step, therefore the gain in amplifier A and amplifier B must be changed in 10 dB steps until the scaling amplifier output is between 3.162 volts and 10.000 volts.

4.20 Integrated circuit IC2324 functions as an UP range comparator for the 3.162 volt reference and the scaling amplifier output. The 3.162 volts is divided down from the 10 volt reference and set by resistor R2325.

4.21 If the scaling amplifier output signal is less than 3.162 volts, the output of IC-2324 will be approximately +14 volts causing transistor Q2312 to turn on, which generates an $\overline{UP}$ signal. If the scaling amplifier output signal is higher than 3.162 volts an $\overline{UP}$ signal will not be generated.

4.22 As mentioned earlier, the scaling amplifier output is applied also to the A/D converter and DN range detector. When transistors Q2308 and Q2310 are conducting IC2329 functions as a DN range comparator receiving one input signal from the scaling amplifier and the other input signal from the 10 volt reference. If the scaling amplifier output is greater than 10 volts the output of IC2329 will be approximately 14 volts, turning on transistor Q2313 and generating a DN signal. If the scaling amplifier output is less than 10 volts a $\overline{DN}$ signal will not be generated.

4.23 Range Counter

4.24 The range counter is a 3-bit binary UP/DN counter. A 100 μsec wide range clock pulse is generated by IC2314 at the beginning of each reading. The range counter will not change state unless either an $\overline{UP}$ or a $\overline{DN}$ occurs simultaneously with the range clock pulse. With each clock the range counter either increases or decreases its binary number by "1".

4.25 The output of the range counter drives the preset logic, the automatic range delay and the range decode logic.

4.26 Range Decode Logic.

4.27 The range decode logic drives the FET switches in the variable gain amplifiers A and B on the analog board. The logic is decoded so that a binary change of "1" in the range counter causes a total gain change of 10 dB in amplifiers A and B.

4.28 Auto Range Delay.

4.29 The auto range delay consists of a flip flop and a unijunction pulse generator that has a time constant of approximately 275 milliseconds in the Level mode, and approximately 375 milliseconds (with C2305 switched in parallel with C2303) in the Noise mode.

4.30 The auto range delay inhibits a reading if a range change has been initiated by holding the reset generator in a "0" state during the delay period. The purpose of the auto range delay is to provide a time period after a range change which allows the analog circuits (those on the 2100 board) to settle and stabilize before initiating a new reading.

4.31 Preset Logic.

4.32 The preset logic is used to preset the tens decade of the readout. The analog circuits work over a 10 dB dynamic range and the automatic ranging logic moves the 10 dB window up and down the scale in 10 dB steps, from +10 dBm to -50 dBm in the level mode and from 0 dBrn to +60 dBrn in the noise mode. The preset logic decodes the range that is to be used and presets the tens decade in increments of 10 dB. The preset number is presented in table B.

Table B. Preset Logic

Preset Number	Level Mode dBm
0	+12 to 0
0	0 to -10
1	-10 to -20
2	-20 to -30
3	-30 to -40
4	-40 to -50
Preset Number	**Noise Mode dBrn**
0	0 to +10
1	+10 to +20

Preset Logic (continued)

Preset Number	Noise Mode dBrn
2	+20 to +30
3	+30 to +40
4	+40 to +50
5	+50 to +60

4.33 The A/D converter processes the analog voltage into a pulse width. During the width of this pulse the gated clock signal is counted by the display counter.

4.34 The A/D converter is log responding, that is, the width of the axis crossing pulse is described by the equation.

$$T = RC \text{ Ln } \frac{E \text{ sig}}{E \text{ ref}}$$

4.35 After the range has been set, as described above, IC2329 functions as a comparator with a parallel RC tied between the negative input and ground. When operating in the minus polarity (i.e. less than or equal to -00.0 dBm), which occurs only in the level mode, the 10 volt reference is connected to the RC at the beginning of the read cycle. The positive input of the comparator is tied through FET Q2308 to the scaling amplifier output. The RC is allowed 1 mS to charge to the 10 volt reference. FET Q2310 is then turned off (by the master reset signal) and the voltage begins to decay exponentially. The positive input voltage is between 10.000 and 3.162 volts. If the input is -00.0 dBm, there is 10 volts on both sides of the comparator. As the minus input voltage decays, the output goes to approximately +14 volts within a few microseconds. The +14 volt output turns on transistor Q2313, generating the $\overline{\text{axis-crossing}}$ signal which stops the reading. From the time FET Q2310 is turned off until the axis crossing occurs, the width of the pulse varies logarithmically from 0 μsec to 1 mS at a rate of 10 μsec per 0.1 dB.

4.36 For positive polarities, which include 0 dBm to +12.2 dBm, and 0 dBrn to +60.2 dBrn, the positive input to comparator IC2329 is connected to a 3.162 volt reference through transistor Q2311. The voltage supplied to the minus input is through transistor Q2309, which is the output from the scaling amplifier. With an input of +00.0 dBm, the voltage across the RC is 3.162 volts, which is the same as the voltage on the positive input. After 1 mS of charge time Q2309 is turned off and the minus input voltage decays. The output of IC2329 then goes to +14 volts, turning on Q2313 and generating the $\overline{\text{axis crossing}}$ signal which stops the reading.

4.37 When the scaling amplifier output goes to +10 volts, corresponding to +10 dBm, the RC circuit will be charged to 10 volts and the positive input to the comparator will still be 3.162 volts. Transistor Q2309 is once again turned off and the RC discharges from the 10 volt signal down to the 3.162 volt reference corresponding to a 10 dB differential. The instant these two voltages cross each other the $\overline{\text{axis crossing}}$ signal is generated.

4.38 In the noise mode the scaling amplifier output, at 0 dBrn, will be 3.162 volts giving no pulse width at Q2313. At +10 dBrn the scaling amplifier output is +10 volts and the RC charges to 10 volts before decaying to 3.162 volts, again corresponding to 10 dB, so the pulse width output at Q2313 once again corresponds to 10 dB.

4.39 200 kHz Oscillator.

4.40 The 200 kHz oscillator is a crystal controlled fixed frequency oscillator, followed by a common emitter stage that squares the output to make it suitable for driving a TTL gate input. The 200 kHz is fed to IC2319 where the frequency is divided by 2 to produce an output of 100 kHz. This output drives IC2312, which is a divide by 10, resulting in 10 kHz. This output drives IC2323 and the divided by 10 output is 1 kHz. The 1 kHz drives IC2318 producing a divided by 10 output of 100 Hz. The 100 Hz drives IC2328, which is divide by 2, thereby producing 50 Hz. The 50 Hz output is then divided by 5 producing 10 Hz. The output at IC2328-12 (10 Hz) is then fed back to IC2319-8 where the output is divided by 4 resulting in a timing frequency of 2.5 Hz. The 50 Hz (IC2328-13), 100 kHz (IC2319-13) and the four outputs of the 1 kHz divider (IC2323-13-9-10-12) 5 kHz (1 kHz A), 2.5 kHz (1 kHz B), 1.25 kHz (1 kHz C), 1 kHz (1 kHz D), are also used for timing frequencies.

4.41 Reset Generator

4.42 The reset generator consists of two flip-flops (IC2311) and it generates a 1 mS wide master reset signal used to perform all resetting. It receives three inputs: one from the auto range delay; one from the 1 kHz output (IC2323-12); and one from either the 2.5 Hz or 50 Hz output. The last two frequencies are switched on the Analog Board and return via J2301-6 as the Clear Master Reset signal. In the level mode the input is 50 Hz, thus the read rate is 50 readings per second. When the 50 Hz signal changes from a "1" state to a "0" state the 1 kHz signal can clock the two flip flops (IC2311). Pin 9 changes to a "1" state 1 mS after the 50 Hz transition from "1" to "0". After 1 mS the next 1 kHz pulse will arrive and pin 9 will return to a "0" state which will set IC2311-12 to a "1" state. As pin 12 goes to a "1", pin 13 goes to a "0" and is fed back to IC2311-7. This prevents any further clocking of the reset generator until it is once again cleared by the 50 Hz signal.

4.43 Clear Logic

4.44 The clear logic is used to reset the display counter to zero. Presetting, described earlier, is accomplished immediately after the 100 μsec wide clear pulse is generated. The clear logic receives three inputs: 1 kHz A, 1 kHz D, and the master reset. The master reset allows a clear pulse to be generated only during the first 1 mS time interval of the read cycle and is disabled at all other times.

4.45 Axis-Crossing Latch.

4.46 The axis-crossing latch receives two inputs: one from the reset generator and one from the A/D converter. The axis-crossing latch is a set-reset flip-flop (IC2320) which is reset with the master reset signal and set by an axis-crossing.

4.47 Gated Clock and Display Limit Logic.

4.48 The gated clock has four inputs: the axis-crossing latch, the reset generator, the 100 kHz time base, and the display limit logic. The output of the axis-crossing latch is in a "1" state until an axis crossing occurs. During the time after the 1 mS reset period the 100 kHz clock frequency appears at the output of the gated clock. This signal is fed to the display counter and the signal is counted until an axis crossing occurs. At this time the gate is disabled by the axis-crossing latch going to a "0" state. The gated clock output can also be disabled by the readout limit. The limit depends on the mode of operation.

4.49 Display Limit Logic.

4.50 One of the inputs to the display limit logic is the level. In the Level mode this line will be in a "0" state. In this mode the two extreme readings are +12.2 dBm and -50.2 dBm. At either of these two extremes, determined by inputs from the display counter, the readout limit line goes to a "0" state, stopping the gated clock output. In the noise mode the level line is in a "1" state and provides two new readout limits. One is +60.2 dBrn and the other is +00.0 dBrn. Both of these limits disable the gated clock.

4.51 Strobe Logic.

4.52 The strobe logic has two inputs: the strobe clock and the 100 kHz time base frequency. When the axis crossing is received the output of the axis-crossing latch, which is the "strobe clock", changes from a "1" state to a "0" state. This transition triggers IC2327-1 setting pin 12 to a "1" state. The negative-going 100 kHz pulse sets pin 9 to a "1". Pin 8 now goes to a "0" and resets pin 12 to a "0" state. The next negative-going edge of 100 kHz resets pin 9 to a "0", which is its original condition. This strobe logic now awaits another strobe clock pulse at pin 1, which does not occur until the next read cycle. The result is a 20 μsec positive-going pulse at pin 9. This pulse is inverted and buffered and is used to strobe the display storage.

4.53 Display Counter and Display Storage.

4.54 The display counter consists of two decade dividers: one for the tenths digit, and one for the units digit. The tens digit consists of three flip-flops connected in series as a binary counter and can be reset and preset. These flip-flops receive information from the preset logic. The display counter receives the clear logic pulse and the gated clock. Each negative going gated clock pulse corresponds to 0.1 dB. The strobe logic and the output of the flip-flops and decades drive the display storage.

4.55 The strobe pulse transfers the information from the display counter to the display storage, where it is held in a series of flip-flops. After the number of the preceding measurement is stored the display counter is reset and preset to make the next reading without interfering with the previous display.

4.56 Readout Multiplex Logic and Display Driver.

4.57 The output of the display storage is fed to the readout multiplex logic. These circuits sweep through the display one readout at a time. The tenths digit is turned on first and its information is transferred from the display storage through the multiplex logic to the display driver. The driver grounds the cathodes necessary to light a particular number. The units and tens digits follow in sequence. The total time required to get a number on the display is 300 μsec. All the displays are off for 700 μsec at which time the sequence starts over. The sweep rate is 1 kHz and each display is on for 100 μsec of the 1 mS that gives a 10 percent duty cycle for each display.

4.58 DC-DC Converters.

4.59 The 48 volt DC-DC converter takes -48 volts from the central office battery and supplies approximately 7 volts dc to the 5 volt regulator. One output from the 5 volt regulator is decoupled and used to supply the power to the logic circuits. The other 5 volt regulated output is connected to the ±14 volt DC-DC converter. Both the positive and negative 14 volt outputs are separately filtered and used to supply power to the analog circuits. In this way all the circuits in the instrument run on regulated power.

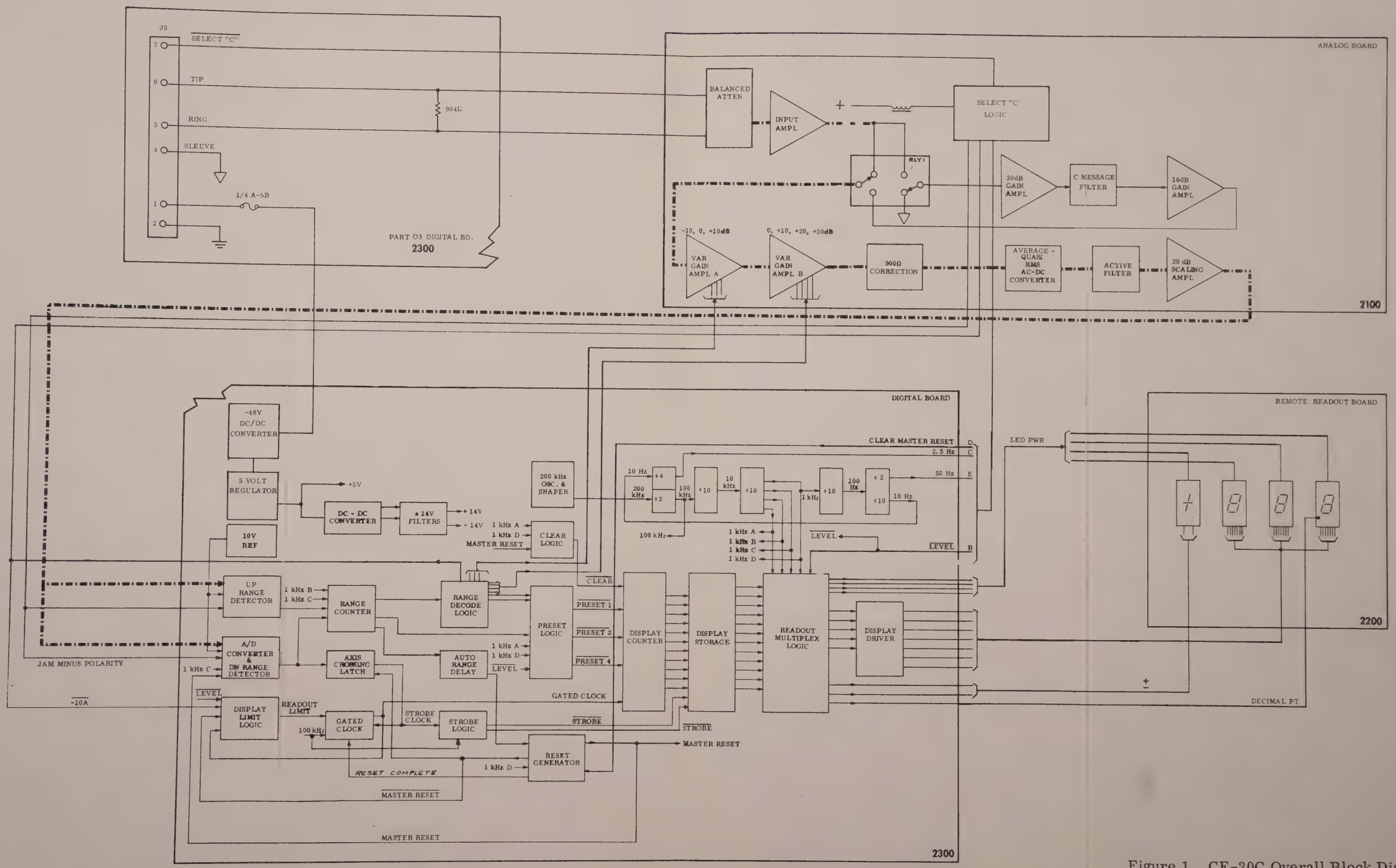


Figure 1. CE-30C Overall Block Diagram

5. MAINTENANCE

GENERAL

5.01 This section provides the information necessary to maintain the Cushman CE-30C in proper operating condition. The performance check may be used for incoming inspection or for determining whether or not the instrument is in need of calibration. The CE-30C may be calibrated as necessary with the Calibration and Adjustment procedures given below.

5.02 If the calibration adjustment procedures do not correct the trouble and if the cause is not apparent or readily repairable, it is recommended that the Cushman Electronics Customer Service Department be contacted for further information or to make arrangements to ship instrument to the factory or a service center for repair. See para. 2.12 and 2.13.

PERFORMANCE CHECKS

5.03 EQUIPMENT REQUIRED

Test Oscillator	HP654A or equivalent
Digital Voltmeter	Dana 4700 or equivalent
Power Supply	Power Designs 6050 or equivalent
Two Binding Post to BNC Adapters	HP10110A or Pomona Model 1296 or equivalent

5.04 PREPARATION FOR TESTS

(1) It is assumed that the CE-30C is not connected to the Portable Console or Test Desk in the following procedures.

(2) Connect the Remote Readout cable to the CE-30C. Plug in the connecting cable assembly.

(3) Before connecting the Power Supply to the CE-30C set the voltage to 48V and set the current limit to greater than 300 mA. Turn off the AC to the Power Supply before connecting to the CE-30C.

(4) Connect the BLACK wire of the Connecting Cable to the + (positive) output of the Power Supply and connect the RED wire to the - (negative) output. Turn on AC to Power Supply.

CAUTION

Do not allow the WHITE wire to be shorted to the RED wire. Serious damage will result if they touch.

(5) Use two Binding Post to BNC Adapters on the Test Oscillator. Connect a GREEN wire to each of the RED binding posts. Connect the YELLOW wire to one of the BLACK binding posts.

5.05 dBm GAIN STEP ACCURACY

(1) Set the Test Oscillator as follows:

FREQUENCY	1 kHz
IMPEDANCE	600Ω BAL
OUTPUT LEVEL	0 dBm
METER	±.2 dBm
LINE	ON

NOTE

The meter setting of +.2 dBm is necessary because of the mismatch between the 600Ω output of the Test Oscillator and the 900Ω input impedance of the CE-30C. The meter setting must be left at +.2 dB for all the level settings given in the following procedure, unless otherwise stated.

(2) Adjust the Test Oscillator to the following output levels. The CE-30C readout should display the Test Oscillator output levels within ±.1 dB.

+10 dBm; 0.0 dBm; -10 dBm; -20 dBm; -30 dBm; -40 dBm; -50 dBm.

5.06 dBm FREQUENCY RESPONSE

(1) Adjust the Test Oscillator Output Level to +10 dBm at 50 Hz. The CE-30C readout should display +10.0 dBm ±.2 dB.

(2) Adjust the Test Oscillator output level to -50 dBm. The CE-30C readout should display -50.0 dBm ±.2 dB.

(3) Repeat steps (1) and (2) with the Test Oscillator set to 50 kHz and using a tolerance of ±.2 dB.

5.07 C MESSAGE GAIN STEP ACCURACY

(1) Turn off the AC to the Power Supply. Connect the WHITE wire to the BLACK wire at the + (plus) output of the Power Supply. Turn on AC to power supply.

(2) Set the Test Oscillator to the following levels at 1 kHz. The CE-30C readout should read as indicated

within the tolerance shown.

Test Osc. Level dBm	CE-30C Readout dBrn	Tolerance dB
-30.0	+60.0	±.2
-40.0	+50.0	±.2
-50.0	+40.0	±.2
-60.0	+30.0	±.2
-70.0	+20.0	±.4
-80.0	+10.0	±.8
-90.0	+0.0	+2.0

5.08 COMMON MODE CHECK

(1) Disconnect one GREEN wire from the Test Oscillator and connect it to the other GREEN wire at the Test Oscillator terminal. (Red terminal of binding post adapter.) Leave Black and White wires connected.

(2) Set the Test Oscillator to +10 dBm.

(3) The CE-30C readout should show less than +20 dBrn.

CALIBRATION AND ADJUSTMENT

5.09 TEST EQUIPMENT REQUIRED

Test Oscillator	HP654A or equivalent
Digital Voltmeter	Dana 4700 or equivalent
Noise Generator	HP8057A or equivalent
Power Supply	Power Designs 6050 or equivalent
Two Binding Post to BNC Adapters	HP10110A or Pomona Model 1296 or equivalent

5.10 PREPARATION FOR CALIBRATION

(1) Remove CE-30C from case by removing the four screws on top. Remove the Input and Remote connectors and slide out of case. Remove two flathead screws from end brackets, two screws from connector bracket and one screw from center post. Fold down rear end bracket (hinged), slide top board back slightly and lay over in the direction of the two interconnecting cables. All adjustments are now accessible. Figure 2.

(2) Connect the Remote Readout to the CE-30C. Plug in the Input Cable.

(3) Before connecting the Power Supply to the CE-30C, set the voltage to 48V and set the current limit to greater than 300 mA. Turn off the AC to the Power Supply before connecting to the CE-30C.

(4) Connect the BLACK wire of the Connecting Cable to the + (plus) output of the Power supply and connect the RED wire to the - (negative) output.

CAUTION

Do not allow the WHITE wire to be shorted to the RED wire. Serious damage will result if they touch.

5.11 POWER SUPPLY TESTS. 2300 BOARD

(1) Turn on the AC to the Power Supply. Current to the CE-30C should be about 100 mA.

(2) Connect the negative lead of the DVM to the negative side of C2319 (500 μF 15V) and the positive lead to the positive side of C2316 (4500 μF 15V).

(3) Set the Power Supply to 45V. DVM should display $\geq$7.8V. Set Power Supply to 55V. The DVM should display $\leq$11.0V.

(4) Connect the positive lead of the DVM to the positive side of C2319 (500μF 15V). Set the Power Supply to 48V. DVM should display between +5.2V and +5.5V. If necessary R2392 (FSV) may be changed. A 10Ω change will give approximately .1V change.

(5) Connect the positive lead of the DVM to J2 pin 1. DVM should display between +14.3V and +14.7V.

(6) Connect the positive lead of the DVM to J1 pin 13. DVM should display between -14.0V and -15.0V. Remove DVM connections and turn off Power Supply.

5.12 PREPARATION FOR CALIBRATION ADJUSTMENTS

(1) Connect two Binding Post to BNC Adapters to the outputs of the Test Oscillator.

(2) Connect a GREEN wire to each RED binding post of the adapters. Connect the YELLOW wire to one of the BLACK binding posts.

(3) Set the Test Oscillator as follows:

FREQUENCY	1 kHz
IMPEDANCE	600Ω BAL.
OUTPUT LEVEL	0 dBm
METER	+.2 dB
LINE	ON

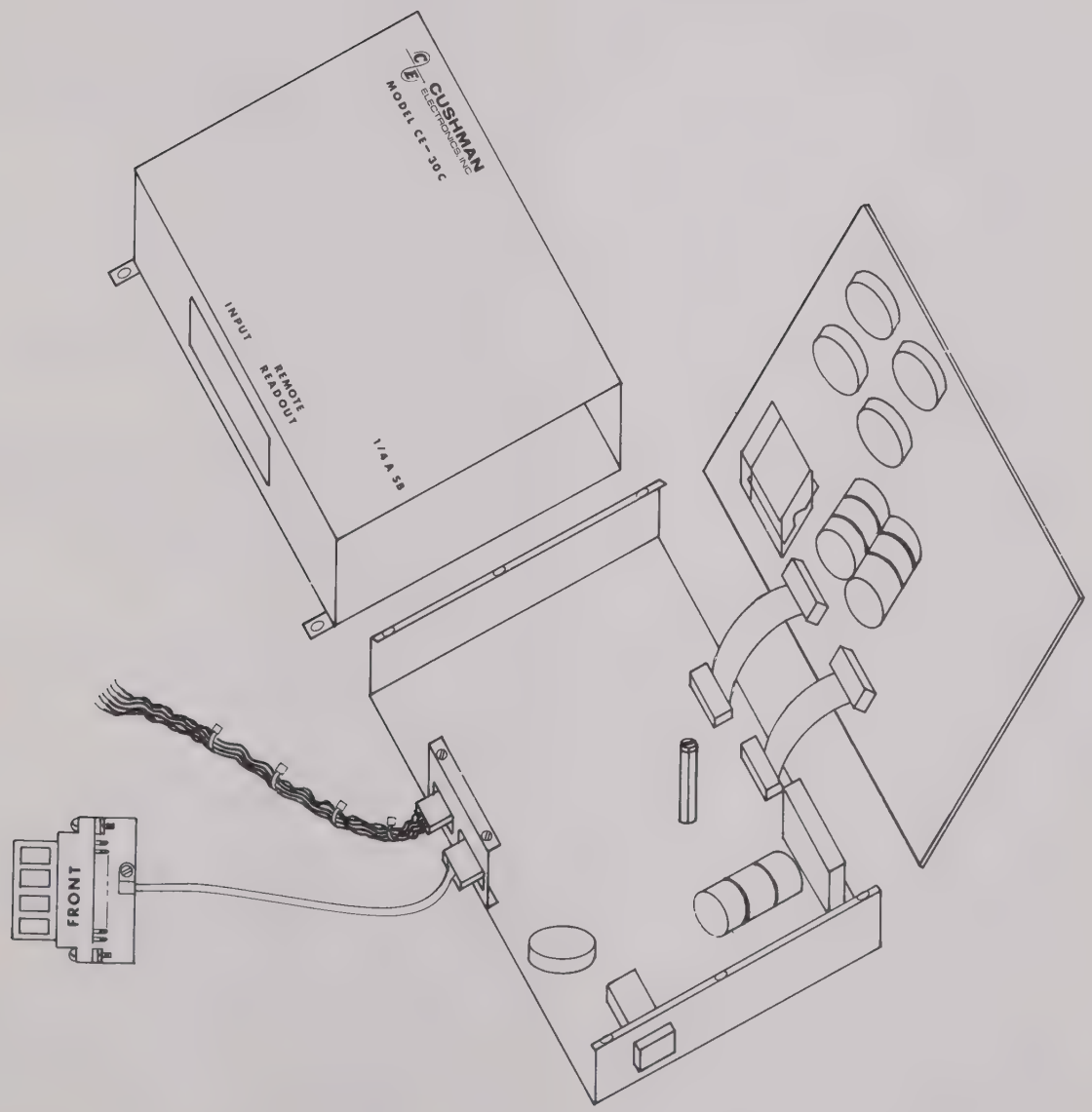


Figure 2. CE-30C Exploded View

NOTE

The Meter setting of +.2 dB is necessary because of the mismatch between the 600Ω output of the Test Oscillator and the 900Ω input impedance of the CE-30C. The meter setting must be left at +.2 dB for all the Level settings given in the following procedure except where specifically indicated otherwise.

(4) Connect the DVM between TP2106 and TP2107.

(5) Set R2317 (10V ADJ) and R2321 (3V ADJ) fully CW. Set R2325 (UPRANGE ADJ) fully CCW. Turn on power supply.

5.13 LEVEL CALIBRATION ADJUSTMENTS. BOARDS 2100, 2300

(1) Adjust R2168 (dBm ADJ) for a DVM reading of 10.000V ±20mV. The CE-30C readout polarity should be negative (-). If not, reduce the Test Oscillator meter reading slowly until it changes to negative; then slowly increase the meter reading to +.2 dB. Disconnect DVM.

(2) Adjust R2317 slowly CCW to the point where the CE-30C readout changes to +00.0.

(3) Set Test Oscillator output so that meter reads +.26 dB. (+.06 dBm).

(4) Adjust R2321 slowly CCW to the point where the CE-30C readout changes to +00.1.

(5) Set Test Oscillator output so that meter reads +.14 dB (-.06 dBm).

(6) Adjust R2325 slowly CW to the point where the CE-30C readout changes to -00.1.

(7) Reset Test Oscillator meter reading to +.2 dB and set output Level to -10.0 dBm.

(8) Adjust R2332 (RC ADJ) until the CE-30C readout bounces between -09.9 and -10.0, then turn R2332 CW 1 turn. The readout should be -10.0.

5.14 NOISE CALIBRATION ADJUSTMENTS

(1) Turn off the AC to the Power Supply. Connect the WHITE wire to the BLACK wire at the Power Supply terminal. Turn on the AC to the Power Supply.

(2) Set the Test Oscillator to -30 dBm (meter set at +.2 dB).

(3) Adjust R2182 (C ADJ) to its mechanical center (10 turns from either end).

(4) Adjust R2173 (Cm ADJ) for a CE-30C readout of +60.0 dBrn.

5.15 COMMON MODE REJECTION ADJUSTMENT

(1) Disconnect one GREEN wire from the RED binding post of one adapter and connect both GREEN wires together at the RED terminal of the other adapter. (BLACK and WHITE wire are still to be connected together.)

(2) Set Test Oscillator Level to +10 dBm.

(3) Adjust R2136 (BALANCE) slowly for lowest possible number on CE-30C readout.

(4) Adjust C2111 (CMR ADJ) slowly for the lowest possible number on the CE-30C readout.

(5) Repeat steps (3) and (4) until the minimum readout is obtained. Readout should be less than +20 dBrn. Disconnect the WHITE wire from the BLACK wire. Reconnect a GREEN wire to each of the Test Oscillator outputs.

5.16 ACCURACY CHECKS

(1) Repeat paragraphs 5.05 and 5.07 to check on accuracy of adjustments.

5.17 WHITE NOISE CHECK

This test is to show that the detector output is RMS responding in the Noise mode and Average responding in the Level mode.

(1) Turn off the AC to the Power Supply and connect the WHITE wire to the BLACK wire at the Power Supply terminal. Turn on the AC to the Power Supply.

(2) Disconnect the two GREEN wires from the Test Oscillator. Use one Binding Post to BNC adapter on the Noise Generator. Connect one GREEN wire to the RED binding post and connect the other GREEN wire and the YELLOW wire to the Black binding post.

(3) Set the Noise Generator as follows:

LINE	ON
NOISE	White
IMPEDANCE	600Ω

LEVEL 94.0 dB

(4) The CE-30C readout should display +49.2 dBrn ±.5 dB.

(5) Disconnect the WHITE wire from the BLACK wire. Observe CAUTION of paragraph 5.04 step 4.

(6) The CE-30C readout should display -31.1 dBm ±.3 dB

End of Calibration

TROUBLESHOOTING

5.18 If trouble should develop in the CE-30C there usually is some external evidence, such as the failure of some of the readout LEDs to light properly.

5.19 External indications of instrument trouble are listed in table C. In each case the circuits where the trouble source may be located are identified. Each trouble source location is included in the overall block diagram for the CE-30C (figure 1). For circuit descriptions refer to Section 4.

Table C. Troubleshooting Chart

Item	Trouble	Possible Trouble Source
	DIGITAL BOARD	
1	All digits blank	a. Power Supply b. Fuses c. Oscillator (200 kHz) d. Dividers
2	One bright digit, others blank	a. Oscillator (200 kHz) b. Dividers
3	Display will not change with input	a. Master reset b. Dividers c. Auto range delay d. Display limit logic e. Axis crossing latch f. Gated clock g. Strobe logic
4	Low reading	a. 10V reference b. A/D converter and down range detector c. Range counter d. Range decode logic e. Auto range delay f. Defective input connector g. Refer to item 6
5	High reading	a. Up range detector b. 10V reference c. A/D converter d. Range counter e. Range decode logic f. Auto range delay g. Refer to item 6
6	Display non-numeric or incorrect	a. Display driver b. Display counter c. Display storage d. Readout multiplex logic e. Preset logic
Item	Trouble	Possible Trouble Source
	ANALOG BOARD	
7	Level readings inaccurate	a. Balanced attenuator b. Input amplifier c. Variable gain A amplifier d. Variable gain B amplifier e. AC/DC converter f. Scaling amplifier
8	C-message noise readings inaccurate	a. Refer to item 7 b. 30-dB gain amplifier c. C-message filter d. 16-dB gain amplifier

6. PARTS LISTS AND SCHEMATIC DIAGRAMS

The following parts lists and schematic diagrams have been arranged in order according to the Circuit Reference Series of board assembly numbers. Refer to paragraph 4.01. Each board and schematic diagram is identified with this number.

Chassis mounted components and Cable Assemblies will be found listed on the 2200 Readout Board parts list page.

ANALOG BOARD 2100

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2100	PC Board Assembly, Analog	7001-0169	Cushman	
	Board, Printed Circuit	D1780-0253	Cushman	
	CAPACITORS			
C1	Not Used			
C2	Mylar, 1μF, ±10%, 600V	1008-0061	Wesco	33M1004K-6
C3	Mylar, 1μF, ±10%, 600V	1008-0061	Wesco	33M1004K-6
C4	Cer, 10pF, ±0.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C5	Cer, 10pF, ±0.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C6	Cer, 10pF, ±0.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C7	Cer, 10pF, ±0.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C8	Cer, 10pF, ±0.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C9	Cer, 10pF, ±0.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C10	Cer, 10pF, ±0.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C11	Trimmer, Cer, 2-8pF, NPO, 350V	1001-0004	Erie	538-002A-2-8
C12	Cer, 5pF, ±0.25pF, 1000V	1005-0056	Erie	831-000-C0G0-509C
C13	Elect., 25μF, +75%-10%, 25V	1013-0010	Sprague	TE-1207
C14	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
C15	Not Used			
C16	Not Used			
C17	Elect., 25μF, +75%-10%, 25V	1013-0010	Sprague	TE-1207
C18	Cer, 5pF, ±0.25pF, 1000V	1005-0056	Erie	831-000-C0G0-509C
C19	Elect., 50μF, +75%-10%, 25V	1013-0021	Sprague	30D506G025CC2
C20	Elect., 15μF, ±10%, 25V	1013-0005	Sprague	TE-1205
C21	Elect., 25μF, +75%-10%, 25V	1013-0010	Sprague	TE-1207
C22	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
C23	Not Used			
C24	Not Used			
C25	Mylar, 0.155μF, ±1%, 100V	1008-0058	IMB	MA2B1553F
C26	Elect., 10μF, +75%-10%, 25V	1013-0020	Sprague	30D106G025BB2
C27	Elect., 10μF, +75%-10%, 25V	1013-0020	Sprague	30D106G025BB2
C28	Elect., 15μF, ±10%, 25V	1013-0005	Sprague	TE-1205
C29	Mylar, 0.165μF, ±1%, 100V	1008-0059	IMB	MA2B1653F
C30	Mylar, 0.39μF, ±1%, 100V	1008-0060	IMB	MA2B394F
C31	Mylar, 0.122μF, ±1%, 100V	1008-0057	IMB	MA2B1223F
C32	Cer, 150pF, ±10%, 1000V	1005-0061	Erie	831-000-X5F0-151K
C33	Mylar, 0.39μF, ±1%, 100V	1008-0060	IMB	MA2B394F
C34	Mylar, 0.034μF, ±1%, 100V	1008-0055	IMB	MA2B343F
C35	Mylar, 0.39μF, ±1%, 100V	1008-0060	IMB	MA2B394F
C36	Cer, 27pF, ±5%, NPO, 1000V	1005-0059	Erie	851-000-C0G0-270J
C37	Cer, 5pF, ±0.25pF, 1000V	1005-0056	Erie	831-000-C0G0-509C
C38	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
C39	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
C40	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
C41	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
	DIODES			
CR1	Si, 1N3064	1281-0013	Sylvania	1N3064
CR2	Si, 1N3064	1281-0013	Sylvania	1N3064
CR3	Si, 1N3064	1281-0013	Sylvania	1N3064
CR4	Si, 1N3064	1281-0013	Sylvania	1N3064
CR5	Si, 1N3064	1281-0013	Sylvania	1N3064

ANALOG BOARD 2100 (CONT.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CR6	Si, 1N3064	1281-0013	Sylvania	1N3064
CR7	Si, 1N3064	1281-0013	Sylvania	1N3064
CR8	Si, 1N3064	1281-0013	Sylvania	1N3064
CR9	Si, 1N3064	1281-0013	Sylvania	1N3064
CR10	Si, 1N3064	1281-0013	Sylvania	1N3064
CR11	Si, 1N3064	1281-0013	Sylvania	1N3064
CR12	Not Used			
CR13	Si, 1N4737A, 7.5V, ±10%, 1W, Zener	1281-0026	Semcor	1N4737A
CR14	Si, 1N3064	1281-0013	Sylvania	1N3064
CR15	Si, 1N3064	1281-0013	Sylvania	1N3064
CR16	Si, 1N3064	1281-0013	Sylvania	1N3064
CR17	Si, 1N3064	1281-0013	Sylvania	1N3064
CR18	Si, 1N3064	1281-0013	Sylvania	1N3064
CR19	Si, 1N3064	1281-0013	Sylvania	1N3064
CR20	Si, 1N3064	1281-0013	Sylvania	1N3064
CR21	Si, 1N3064	1281-0013	Sylvania	1N3064
CR22	Si, 1N3064	1281-0013	Sylvania	1N3064
CR23	Si, 1N3064	1281-0013	Sylvania	1N3064
	INDUCTORS			
L1	PC BD Mt Pot Core, 800mH, ±5%	C1596-0034-04	Aztec	11742
L2	PC BD MT Pot Core, 80mH, ±5%	C1596-0034-02	Aztec	11743
L3	PC BD MT Pot Core, 110mH, ±5%	C1596-0034-03	Aztec	11744
L4	PC BD MT Pot Core, 55mH, ±5%	C1596-0034-01	Aztec	11745
	INTEGRATED CIRCUITS			
IC1	Wideband OP Amp, HA2911	2025-0033	Harris	HA2-911-5
IC2	Wideband OP Amp, HA2911	2025-0033	Harris	HA2-911-5
IC3	Wideband OP Amp, HA2911	2025-0033	Harris	HA2-911-5
IC4	Wideband OP Amp, HA2911	2025-0033	Harris	HA2-911-5
IC5	Wideband OP Amp, HA2911	2025-0033	Harris	HA2-911-5
IC6	OP Amp, LM301A	2025-0032	National	LM301A
IC7	Linear, μA748C	2025-0034	Fairchild	μA748C
IC8	Linear, μA748C	2025-0034	Fairchild	μA748C
IC9	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC10	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
K1	Relay, 6V DC, 2 Pole	1313-0009	American Zettler	A2-420-15-40L
	JACKS			
J1	Dual Inline I.C. Socket, 14-Pin	2606-0004	Cinch	133-51-02-003
J2	Dual Inline I.C. Socket, 14-Pin	2606-0004	Cinch	133-51-02-003
	RESISTORS			
R1	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R2	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R3	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R4	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R5	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R6	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R7	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R8	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R9	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R10	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R11	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R12	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R13	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R14	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R15	Comp, 1 Meg, ±5%, 1/4W	1066-1055	Allen-Bradley	CB 1055

ANALOG BOARD 2100 (CONT.)

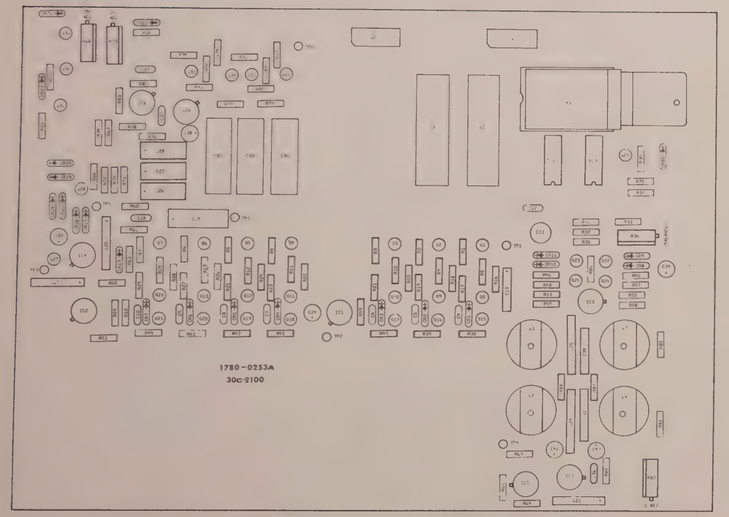
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R16	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R17	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R18	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R19	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R20	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R21	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R22	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R23	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R24	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R25	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R26	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R27	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R28	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R29	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R30	Met Film, 40.2kΩ, ±0.1%, 1/10W	1074-0064	Dale	MF-1/10-T-9
R31	Met Film, 93.1kΩ, ±0.1%, 1/10W	1074-0067	Dale	MF-1/10-T-9
R32	Comp, 39kΩ, ±5%, 1/4W	1066-3935	Allen-Bradley	CB 3935
R33	Met Film, 93.1kΩ, ±0.1%, 1/10W	1074-0067	Dale	MF-1/10-T-9
R34	Met Film, 2.74k, ±0.1%, 1/8W	1075-0071	Dale	MFF-1/8-T-1
R35	Met Film, 15.74kΩ, ±0.1%, 1/10W	1074-0061	Dale	MF-1/10-T-9
R36	Trimmer, Cer, 100Ω, ±10%, 3/4W	1215-0010	Beckman	89WR
R37	Met Film, 15.74kΩ, ±0.1%, 1/10W	1074-0061	Dale	MF-1/10-T-9
R38	Met Film, 31.62kΩ, ±0.1%, 1/10W	1074-0063	Dale	MF-1/10-T-9
R39	Met Film, 9.97kΩ, ±0.1%, 1/10W	1074-0059	Dale	MF-1/10-T-9
R40	Met Film, 3.132kΩ, ±0.1%, 1/10W	1074-0054	Dale	MF-1/10-T-9
R41	Met Film, 100kΩ, ±0.1%, 1/10W	1074-0069	Dale	MF-1/10-T-9
R42	Met Film, 31.62kΩ, ±0.1%, 1/10W	1074-0063	Dale	MF-1/10-T-9
R43	Met Film, 9.97kΩ, ±0.1%, 1/10W	1074-0059	Dale	MF-1/10-T-9
R44	Met Film, 3.132kΩ, ±0.1%, 1/10W	1074-0054	Dale	MF-1/10-T-9
R45	Comp, 150kΩ, ±5%, 1/4W	1066-1545	Allen-Bradley	CB 1545
R46	Comp, 150kΩ, ±5%, 1/4W	1066-1545	Allen-Bradley	CB 1545
R47	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R48	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R49	Met Film, 10kΩ, ±0.1%, 1/10W	1074-0060	Dale	MF-1/10-T-9
R50	Met Film, 100kΩ, ±0.1%, 1/10W	1074-0069	Dale	MF-1/10-T-9
R51	Met Film, 3.01kΩ, ±0.1%, 1/10W	1074-0053	Dale	MF-1/10-T-9
R52	Met Film, 1.585kΩ, ±0.1%, 1/10W	1074-0052	Dale	MF-1/10-T-9
R53	Met Film, 1.585kΩ, ±0.1%, 1/10W	1074-0052	Dale	MF-1/10-T-9
R54	Met Film, 10kΩ, ±0.1%, 1/10W	1074-0060	Dale	MF-1/10-T-9
R55	Comp, 1 Meg, ±5%, 1/4W	1066-1055	Allen-Bradley	CB 1055
R56	Comp, 1 Meg, ±5%, 1/4W	1066-1055	Allen-Bradley	CB 1055
R57	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R58	Met Film, 10kΩ, ±0.1%, 1/10W	1074-0060	Dale	MF-1/10-T-9
R59	Met Film, 2.21kΩ, ±1%, 1/8W	1075-0010	Dale	MFF-1/8-T-1
R60	Met Film, 9.97kΩ, ±0.1%, 1/10W	1074-0059	Dale	MF-1/10-T-9
R61	Met Film, 10kΩ, ±0.1%, 1/10W	1074-0060	Dale	MF-1/10-T-9
R62	Met Film, 1kΩ, ±0.1%, 1/10W	1074-0050	Dale	MF-1/10-T-9
R63	Comp, 6.8kΩ, ±5%, 1/4W	1066-6825	Allen-Bradley	CB 6825
R64	Met Film, 3.132kΩ, ±0.1%, 1/10W	1074-0054	Dale	MF-1/10-T-9
R65	Met Film, 100kΩ, ±0.1%, 1/10W	1074-0069	Dale	MF-1/10-T-9

ANALOG BOARD 2100 (CONT.)

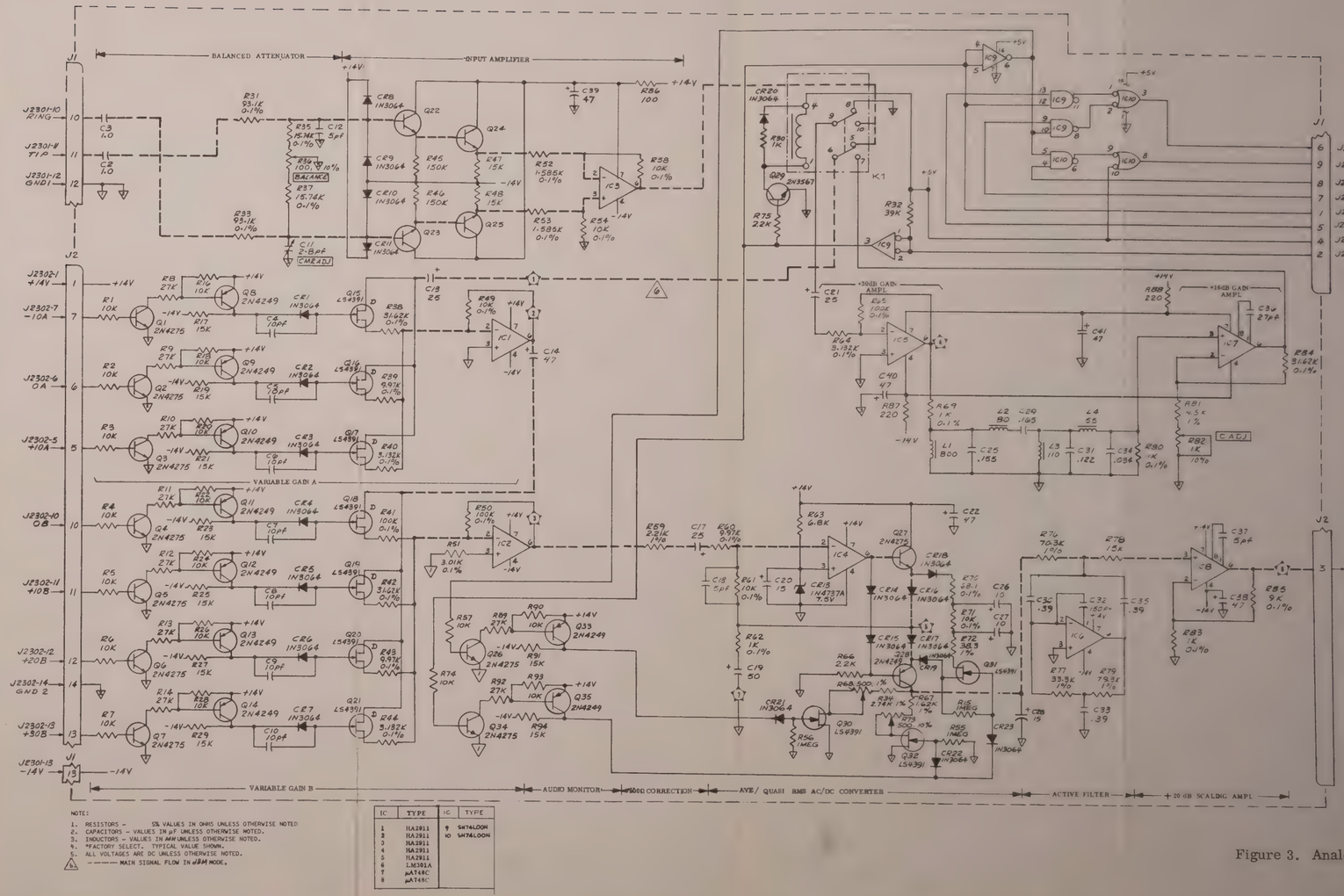
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R66	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB 2225
R67	Met Film, 1.62kΩ, ±1%, 1/8W	1075-0070	Dale	MFF-1/8-T-9
R68	Trimmer, Cer., 500Ω ±10%, 3/4W	1215-0011	Helitrim	89WR
R69	Met Film, 1kΩ, ±0.1%, 1/10W	1074-0050	Dale	MF-1/10-T-9
R70	Met Film, 68.1Ω, ±0.1%, 1/10W	1074-0048	Dale	MF-1/10-T-9
R71	Met Film, 10kΩ, ±0.1%, 1/10W	1074-0060	Dale	MF-1/10-T-9
R72	Met Film, 38.3Ω, ±1%, 1/10W	1074-0096	Dale	MF-1/10-T-9
R73	Trimmer, Cer, 500Ω, ±10%, 3/4W	1215-0011	Beckman	89WR
R74	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R75	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB 2225
R76	Met Film, 70.3kΩ, ±1%, 1/8W	1075-0073	Dale	MFF-1/8-T-1
R77	Met Film, 33.3kΩ, ±1%, 1/8W	1075-0072	Dale	MFF-1/8-T-1
R78	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R79	Met Film, 79.3kΩ, ±1%, 1/8W	1075-0074	Dale	MFF-1/8-T-1
R80	Met Film, 1kΩ, ±0.1%, 1/10W	1074-0050	Dale	MF-1/10-T-9
R81	Met Film, 4.5kΩ, ±1%, 1/8W	1075-0066	Dale	MFF-1/8-T-9
R82	Trimmer, Cer., 1kΩ, ±10%, 3/4W	1215-0013	Beckman	89WR
R83	Met Film, 1kΩ, ±0.1%, 1/10W	1074-0050	Dale	MF-1/10-T-9
R84	Met Film, 31.62kΩ, ±0.1%, 1/10W	1074-0063	Dale	MF-1/10-T-9
R85	Met Film, 9kΩ, ±0.1%, 1/10W	1074-0058	Dale	MF-1/10-T-9
R86	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB 1015
R87	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB 2215
R88	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB 2215
R89	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R90	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R91	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R92	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R93	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R94	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
	TRANSISTORS			
Q1	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q2	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q3	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q4	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q5	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q6	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q7	2N4275	1272-0016	Fairchild	2N4275
Q8	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q9	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q10	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q11	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q12	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q13	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q14	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q15	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q16	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q17	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q18	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q19	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q20	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391

ANALOG BOARD 2100 (CONT.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
Q21	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q22	2N5962	1272-0059	Fairchild	2N5962
Q23	2N5962	1272-0059	Fairchild	2N5962
Q24	2N5962	1272-0059	Fairchild	2N5962
Q25	2N5962	1272-0059	Fairchild	2N5962
Q26	2N4275	1272-0016	Fairchild	2N4275
Q27	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q28	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249



2100



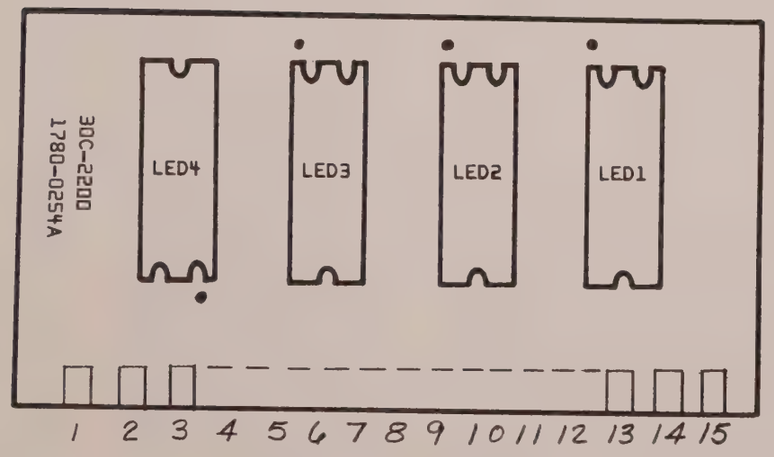
IC	TYPE	IC	TYPE
1	HA2911	9	SN74LOON
2	HA2911	10	SN74LOON
3	HA2911		
4	HA2911		
5	HA2911		
6	LM301A		
7	μAT48C		
8	μAT48C		

NOTE:
1. RESISTORS – 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN MH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
- – – – – MAIN SIGNAL FLOW IN 2100 MODE.

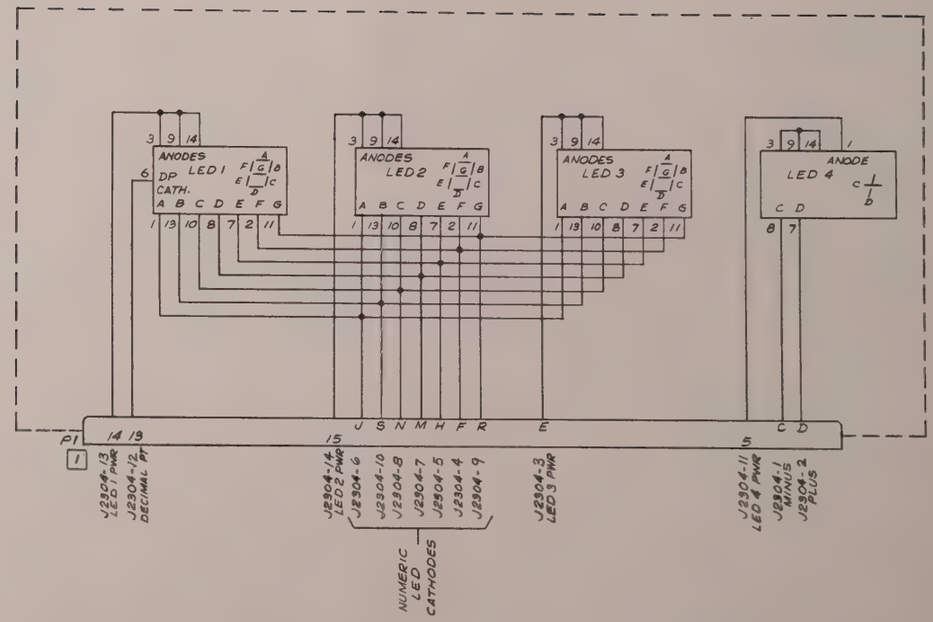
Figure 3. Analog Board. 2100

READOUT BOARD 2200 CHASSIS AND CABLE ASSEMBLIES

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2200	PC Board Assembly, Readout	7001-0170	Cushman	
	Board, Printed Circuit	C1780-0254	Cushman	
	DIODES			
LED1	Alpha-Numeric Segment Readout	1281-0039	Litronix	Data Lit 10A
LED2	Alpha-Numeric Segment Readout	1281-0039	Litronix	Data Lit 10A
LED3	Alpha-Numeric Segment Readout	1281-0039	Litronix	Data Lit 10A
LED4	Polarity & Overflow Segment Readout	1281-0040	Litronix	Data Lit 101A
	CHASSIS			
F3001	Fuse, 1/4A SB	1955-0013	Littelfuse	313.250
	Fuse Assembly	7041-0005	Cushman	
	Transistor Regulator Assembly	7041-0006	Cushman	
	CABLE ASSEMBLIES			
	Remote Readout	7030-0078	Cushman	
	Remote Input	7030-0079	Cushman	
	Interconnect, 14 Conductor	3173-0005	Cushman	



2200



NOTES: [A] THIS REMOTE READOUT P.C. BOARD ASSEMBLY IS CONNECTED TO J2304 ON THE DIGITAL PC BOARD ASSEMBLY VIA A CABLE ASSEMBLY.

Figure 4. Remote Readout Board. 2200

DIGITAL BOARD 2300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2300	PC Board Assembly, Digital	7001-0171	Cushman	
	Board, Printed Circuit	D1780-0255	Cushman	
	CAPACITORS			
C1	Cer, 10pF, ±.5pF, NPO, 1000V	1005-0057	Erie	831-000-C0G0-100D
C2	Poly., 0.082μF, ±2%, 100V	1008-0056	Wesco	32P8202G-1
C3	Tantalum, 6.8μF, ±5%, 35V	1011-0002	Dickson	D6R8GSB35J
C4	Cer, 0.002μF, ±20%, 500V	1005-0003	Erie	831-060-Z5U0-0202M
C5	Tantalum, 2.2μF, ±5%, 35V	1011-0001	Dickson	D2R2GSB35J
C6	Cer, 0.002μF, ±20%, 500V	1005-0003	Erie	831-060-Z5U0-0202M
C7	Mica, 100pF ±5%, 500V	1002-0011	Elmenco	DM15-E-270J
C8	Cer, 1000pF, ±10%, 1000V	1005-0062	Erie	801-000-X5F0-102K
C9	Cer, 5pF, ±.25pF, NPO, 1000V	1005-0056	Erie	831-000-C0G0-509C
C10	Cer, 47pF, ±5%, NPO, 1000V	1005-0060	Erie	851-000-C0G0-470J
C11	Cer, 47pF, ±5%, NPO, 1000V	1005-0060	Erie	851-000-C0G0-470J
C12	Cer, 47pF, ±5%, NPO, 1000V	1005-0060	Erie	851-000-C0G0-470J
C13	Cer, 47pF, ±5%, NPO, 1000V	1005-0060	Erie	851-000-C0G0-470J
C14	Cer, 47pF, ±5%, NPO, 1000V	1005-0060	Erie	851-000-C0G0-470J
C15	Cer, 47pF, ±5%, NPO, 1000V	1005-0060	Erie	851-000-C0G0-470J
C16	Elect., 4500μF, +150-10%, 15V	1014-0013	Syncro	EMW2868-4500-15
C17	Cer, 6.8μF, ±5%, 35V	1011-0002	Dickson	D6R8GSB35J
C18	Elect, 10μF, -10%, 150V	1013-0017	Sprague	TE-1507
C19	Elect., 500μF, 15V	1013-0014	San Fernando	MAC 15.501
C20	Cer, 0.01μF, +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UO-103Z
C21	Cer, 0.01μF, +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UO-103Z
C22	Tantalum, 6.8μF, ±5%, 35V	1011-0002	Dickson	D6R8GSB35J
C23	Cer, 0.01μF, +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UO-103Z
C24	Tantalum, 6.8μF, ±5%, 35V	1011-0002	Dickson	D6R8GSB35J
C25	Cer, 0.01μF, +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UO-103Z
C26	Tantalum, 6.8μF, ±5%, 35V	1011-0002	Dickson	D6R8GSB35J
C27	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
C28	Tantalum, 47μF, ±20%, 20V	1011-0009	Dickson	D47GSC20M
C29	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
	CRYSTAL			
Y1	200.000 kHz	B2035-0015	Cushman	
	DIODES			
CR1	Si, 1N4739A, 9.1V, 5%, 1W, Zener	1281-0027	Semcor	1N4739A
CR2	Si, 1N3064	1281-0013	Sylvania	1N3064
CR3	Si, 1N827, 6.2V, Zener	1281-0038	Semcor	1N827
CR4	Si, 1N3064	1281-0013	Sylvania	1N3064
CR5	Si, 1N3064	1281-0013	Sylvania	1N3064
CR6	Si, 1N3064	1281-0013	Sylvania	1N3064
CR7	Si, 1N3064	1281-0013	Sylvania	1N3064
CR8	Si, 1N3064	1281-0013	Sylvania	1N3064
CR9	Si, 1N3064	1281-0013	Sylvania	1N3064
CR10	Si, 1N3064	1281-0013	Sylvania	1N3064
CR11	Si, 1N3064	1281-0013	Sylvania	1N3064
CR12	3SF1 Silicon	1281-0053	Semtec	3SF1
CR13	3SF1 Silicon	1281-0053	Semtec	3SF1
CR14	Si, 1N5062	1281-0030	G.E.	1N5062
CR15	Si, 1N752A, 5.6V, 5%, .4W, Zener	1281-0042	Motorola	1N752A

DIGITAL BOARD 2300 (CONT.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CR16	3SF1 Silicon	1281-0053	Semtec	3SF1
CR17	3SF1 Silicon	1281-0053	Semtec	3SF1
CR18	9.1V ±5%, Zener	1281-0027	Semcor	ZD9.1B
	INDUCTORS			
L1	Choke, 22mH, 15%, RF	1585-0029	Delevan	2534-56
L2	Choke, 100μH, 5%, RF	1585-0017	Delevan	1537-76
L3	Choke, 100μH, 5%, RF	1585-0017	Delevan	1537-76
L4	Inductor, Toroidal	B1596-0059	Cushman	
L5	Inductor, Toroidal	B1596-0059	Cushman	
	INTEGRATED CIRCUITS			
IC1	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC2	Dual J-K Master-Slave Flip-Flop, SN74L73N	2025-0041	T.I.	SN74L73N
IC3	Dual J-K Master-Slave Flip-Flop, SN74L73N	2025-0041	T.I.	SN74L73N
IC4	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC5	2-Input Nor Gate, SN74L02N	2025-0037	T.I.	SN74L02N
IC6	2-Input Nor Gate, SN74L02N	2025-0037	T.I.	SN74L02N
IC7	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC8	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC9	HEX Inverter, SN74L04N	2025-0038	T.I.	SN74L04N
IC10	Triple 3-Input Nand Gate, SN74L10N	2025-0039	T.I.	SN74L10N
IC11	Dual J-K Master-Slave Flip-Flop, SN74L73N	2025-0041	T.I.	SN74L73N
IC12	Four-Bit Binary Counter, SN74L93N	2025-0044	T.I.	SN74L93N
IC13	Linear, μA748C	2025-0034	Fairchild	μA748C
IC14	Dual 4-Input Nand Gate, SN74L20N	2025-0040	T.I.	SN74L20N
IC15	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC16	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC17	Dual 4-Input Nand Gate, SN74L20N	2025-0040	T.I.	SN74L20N
IC18	Four-Bit Binary Counter, SN74L93N	2025-0044	T.I.	SN74L93N
IC19	Four-Bit Binary Counter, SN74L93N	2025-0044	T.I.	SN74L93N
IC20	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC21	2-Input Positive Nand Gate SN74L00N	2025-0036	T.I.	SN74L00N
IC22	HEX Inverter, SN74L04N	2025-0038	T.I.	SN74L04N
IC23	Four-Bit Binary Counter, SN74L93N	2025-0044	T.I.	SN74L93N
IC24	Linear, μA748C	2025-0034	Fairchild	μA748C
IC25	Dual D-Type Edge Triggered Flip-Flop, SN74L74N	2025-0042	T.I.	SN74L74N

DIGITAL BOARD 2300 (CONT.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
IC26	HEX Inverter, SN74L04N	2025-0038	T.I.	SN74L04N
IC27	Dual J-K Master-Slave Flip-Flop, SN74L73N	2025-0041	T.I.	SN74L73N
IC28	Four-Bit Binary Counter, SN74L93N	2025-0044	T.I.	SN74L93N
IC29	Linear, μA748C	2025-0034	Fairchild	μA748C
IC30	Dual D-Type Edge Triggered Flip-Flop, SN74L74N	2025-0042	T.I.	SN74L74N
IC31	Dual J-K Master-Slave Flip-Flop, SN74L78N	2025-0043	T.I.	SN74L78N
IC32	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC33	Triple 3-Input Nand Gate, SN74L10N	2025-0039	T.I.	SN74L10N
IC34	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC35	Dual D-Type Edge Triggered Flip-Flop, SN74L74N	2025-0042	T.I.	SN74L74N
IC36	Dual J-K Master-Slave Flip-Flop, SN74L78N	2025-0043	T.I.	SN74L78N
IC37	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC38	Dual J-K Master-Slave Flip-Flop, SN74L73N	2025-0041	T.I.	SN74L73N
IC39	Dual D-Type Edge Triggered Flip-Flop, SN74L74N	2025-0042	T.I.	SN74L74N
IC40	Four-Bit Binary Counter, SN74L93N	2025-0044	T.I.	SN74L93N
IC41	Dual 4-Input Nand Gate, SN74L20N	2025-0040	T.I.	SN74L20N
IC42	Dual 4-Input Nand Gate, SN74L20N	2025-0040	T.I.	SN74L20N
IC43	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC44	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC45	Dual D-Type Edge Triggered Flip-Flop, SN74L74N	2025-0042	T.I.	SN74L74N
IC46	Four-Bit Binary Counter, SN74L93N	2025-0044	T.I.	SN74L93N
IC47	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC48	2-Input Nor Gate, SN74L02N	2025-0037	T.I.	SN74L02N
IC49	2-Input Positive Nand Gate, SN74L00N	2025-0036	T.I.	SN74L00N
IC50	Dual D-Type Edge Triggered Flip-Flop, SN74L74N	2025-0042	T.I.	SN74L74N
IC51	BCD-to-Seven-Segment Decoder-Driver, SN7447N	2025-0035	T.I.	SN7447N
	JACKS			
J1	Dual Inline I.C. Socket, 14-pin	2606-0004	Cinch	133-51-02-003
J2	Dual Inline I.C. Socket, 14-pin	2606-0004	Cinch	133-51-02-003
J3	Not Used			
J4	Connectors, 15 Contact Miniature Receptacle	2535-0048	Amphenol	17-80150
J5	Connectors, 9 Contact Miniature Receptacle	2535-0047	Amphenol	17-80090

5601-0032

DIGITAL BOARD 2300 (CONT.)

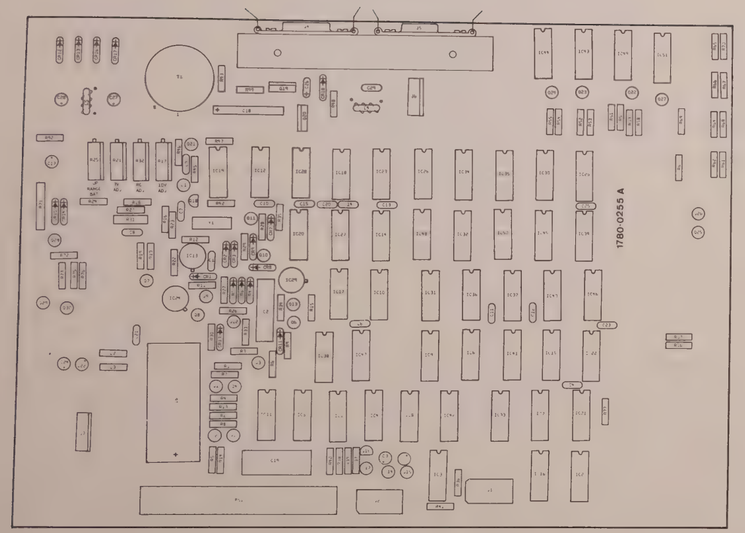
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q2	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q3	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q4	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q5	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q6	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q7	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q8	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q9	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q10	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q11	Si, FET, N-Channel, LS4391	1272-0042	Ledel	LS4391
Q12	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q13	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q14	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q15	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q16	Si, Unijunction, 2N4870	1272-0047	Motorola	2N4870
Q17	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q18	Si, NPN, 2N5089	1272-0031	Motorola	2N5089
Q19	D44R1, NPN, Silicon	1272-0063	GE	GED44R1
Q20	D44R1, NPN, Silicon	1272-0063	GE	GED44R1
Q21	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q22	Si, PNP, 2N3644	1272-0040	Fairchild	2N3644
Q23	Si, PNP, 2N3644	1272-0040	Fairchild	2N3644
Q24	Si, PNP, 2N3644	1272-0040	Fairchild	2N3644
Q25	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q26	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q27	Si, NPN, 2N3644	1272-0040	Fairchild	2N3644
Q28	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q29	Si, NPN, 2N3567	1272-0014	Fairchild	2N3567
Q30	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
	POWER SUPPLY			
PS1	Converter, +14V & -14V DC/DC	B1574-0001	Shane	P1550A
	RESISTORS			
R1	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R2	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R3	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB 1535
R4	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R5	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035

DIGITAL BOARD 2300 (CONT.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R6	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R7	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R8	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R9	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB 2735
R10	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R11	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley	CB 3325
R12	Met Film, 499Ω, ±0.1%, 1/10W	1074-0068	Dale	MF-1/10-T-9
R13	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R14	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R15	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R16	Met Film, 3.92kΩ, ±0.1%, 1/10W	1074-0055	Dale	MF-1/10-T-9
R17	Trimmer, Cer, 1kΩ, ±10%, 3/4W	1215-0013	Beckman	89WR
R18	Met Film, 5.62kΩ, ±0.1%, 1/10W	1074-0056	Dale	MF-1/10-T-9
R19	Comp, 18kΩ, ±5%, 1/4W	1066-1835	Allen-Bradley	CB 1835
R20	Met Film, 3.01kΩ, ±0.1%, 1/10W	1074-0053	Dale	MF-1/10-T-9
R21	Trimmer, Cer, 500Ω, ±10%, 3/4W	1215-0011	Beckman	89WR
R22	Met Film, 6.81kΩ, ±0.1%, 1/10W	1074-0057	Dale	MF-1/10-T-9
R23	Met Film, 6.81kΩ, ±0.1%, 1/10W	1074-0057	Dale	MF-1/10-T-9
R24	Met Film, 3.01kΩ, ±0.1%, 1/10W	1074-0053	Dale	MF-1/10-T-9
R25	Trimmer, Cer, 500Ω, ±10%, 3/4W	1215-0011	Beckman	89WR
R26	Comp, 1 MΩ, ±5%, 1/4W	1066-1055	Allen-Bradley	CB 1055
R27	Comp, 1 MΩ, ±5%, 1/4W	1066-1055	Allen-Bradley	CB 1055
R28	Comp, 1 MΩ, ±5%, 1/4W	1066-1055	Allen-Bradley	CB 1055
R29	Comp, 1 MΩ, ±5%, 1/4W	1066-1055	Allen-Bradley	CB 1055
R30	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R31	WW, 10kΩ, ±0.5%, 0.15W, +108 m/c°	1177-0005	Jordon Elect.	Type J110
R32	Trimmer, Cer, 1kΩ, ±10%, 3/4W	1215-0013	Beckman	89WR
R33	Comp, 5.1kΩ, ±5%, 1/4W	1066-5125	Allen-Bradley	CB 5125
R34	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R35	Comp, 5.1kΩ, ±5%, 1/4W	1066-5125	Allen-Bradley	CB 5125
R36	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R37	Comp, 39kΩ, ±5%, 1/4W	1066-3935	Allen-Bradley	CB 3935
R38	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB 5615
R39	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB 1015
R40	Comp, 5.1kΩ, ±5%, 1/4W	1066-5125	Allen-Bradley	CB 5125
R41	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R42	Comp, 560kΩ, ±5%, 1/4W	1066-5645	Allen-Bradley	CB 5645
R43	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley	CB 8225
R44	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R45	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB 1025
R46	Comp, 33kΩ, ±5%, 1/4W	1066-3335	Allen-Bradley	CB 3335
R47	Comp, 5.1kΩ, ±5%, 1/4W	1066-5125	Allen-Bradley	CB 5125
R48	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R49	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB 1015
R50	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB 1025
R51	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB 2225
R52	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB 1025
R53	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB 2225
R54	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB 1025
R55	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB 2225

DIGITAL BOARD 2300 (CONT.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R56	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB 1525
R57	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB 1525
R58	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB 1525
R59	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB 2225
R60	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB 1015
R61	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB 1015
R62	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB 1015
R63	Comp, 240Ω, ±5%, 1/4W	1066-2415	Allen-Bradley	CB 2415
R64	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R65	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R66	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R67	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R68	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R69	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R70	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB 2705
R71	WW, .5Ω, ±3%, 3W	1159-0002	Dale	RS 2B
R72	Comp, 390Ω, ±5%, 1/4W	1066-3915	Allen-Bradley	CB 3915
R73	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB 1035
R74	WW, 601.8Ω, ±0.1%, 3W	1178-0001	RCL	T-2A
R75	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB 1015
R76	Comp, 56Ω, ±5%, 1/4W	1066-5605	Allen-Bradley	CB 5605
R77	WW, 904Ω, ±0.1%, 3W	1178-0002	RCL	T-2A
R78	Not Used			
R79	Not Used			
R80	Not Used			
R81	Not Used			
R82	Not Used			
R83	Not Used			
R84	Not Used			
R85	Not Used			
R86	Not Used			
R87	Not Used			
R88	Not Used			
R89	Not Used			
R90	Not Used			
R91	Not Used			
R92	Comp, FSV, ±5%, 1/4W	1066-XXXX	Allen-Bradley	Type CB
T1	Transformer, -48V DC/DC	C1575-0020	Cushman	



2300

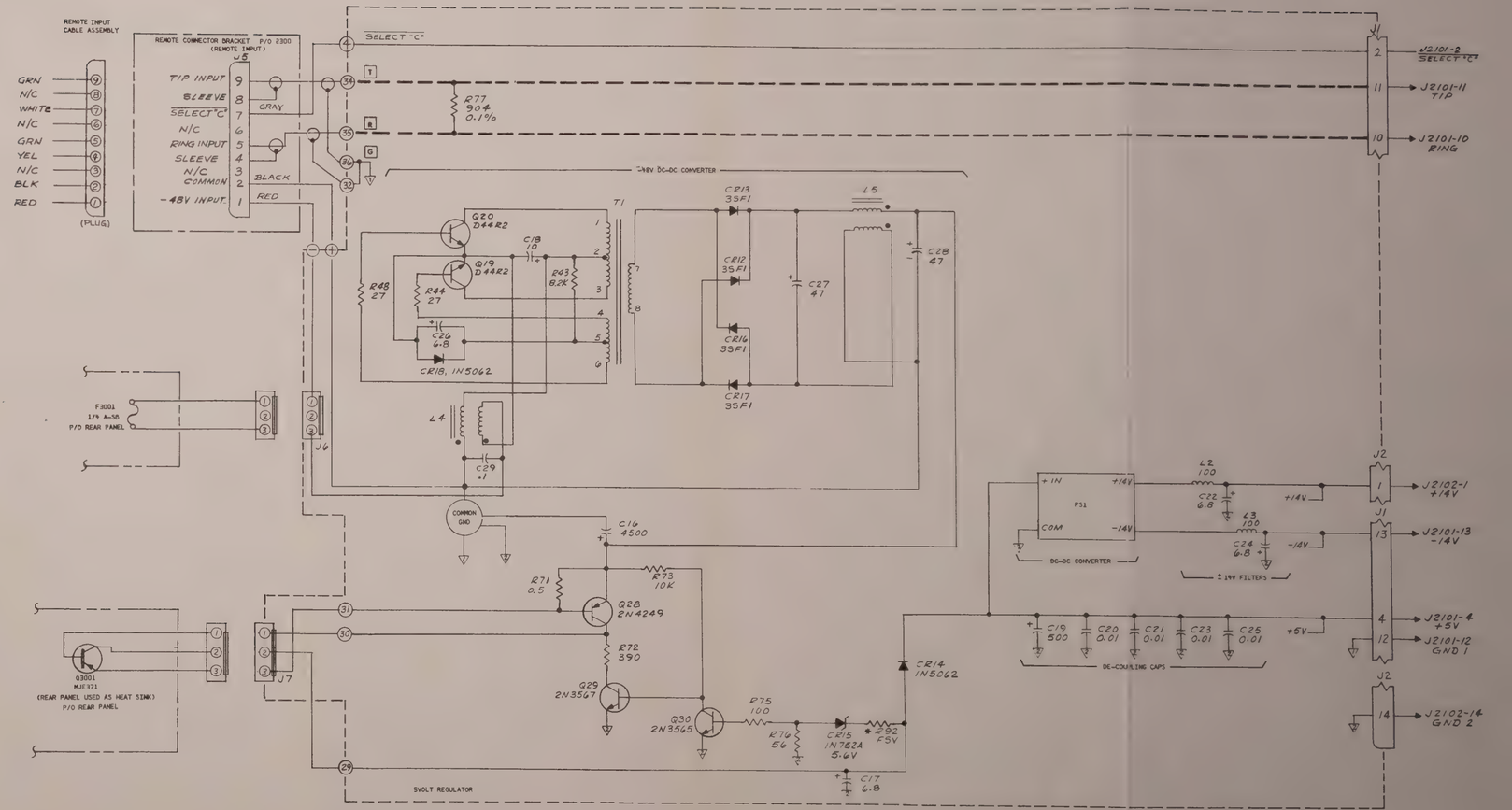
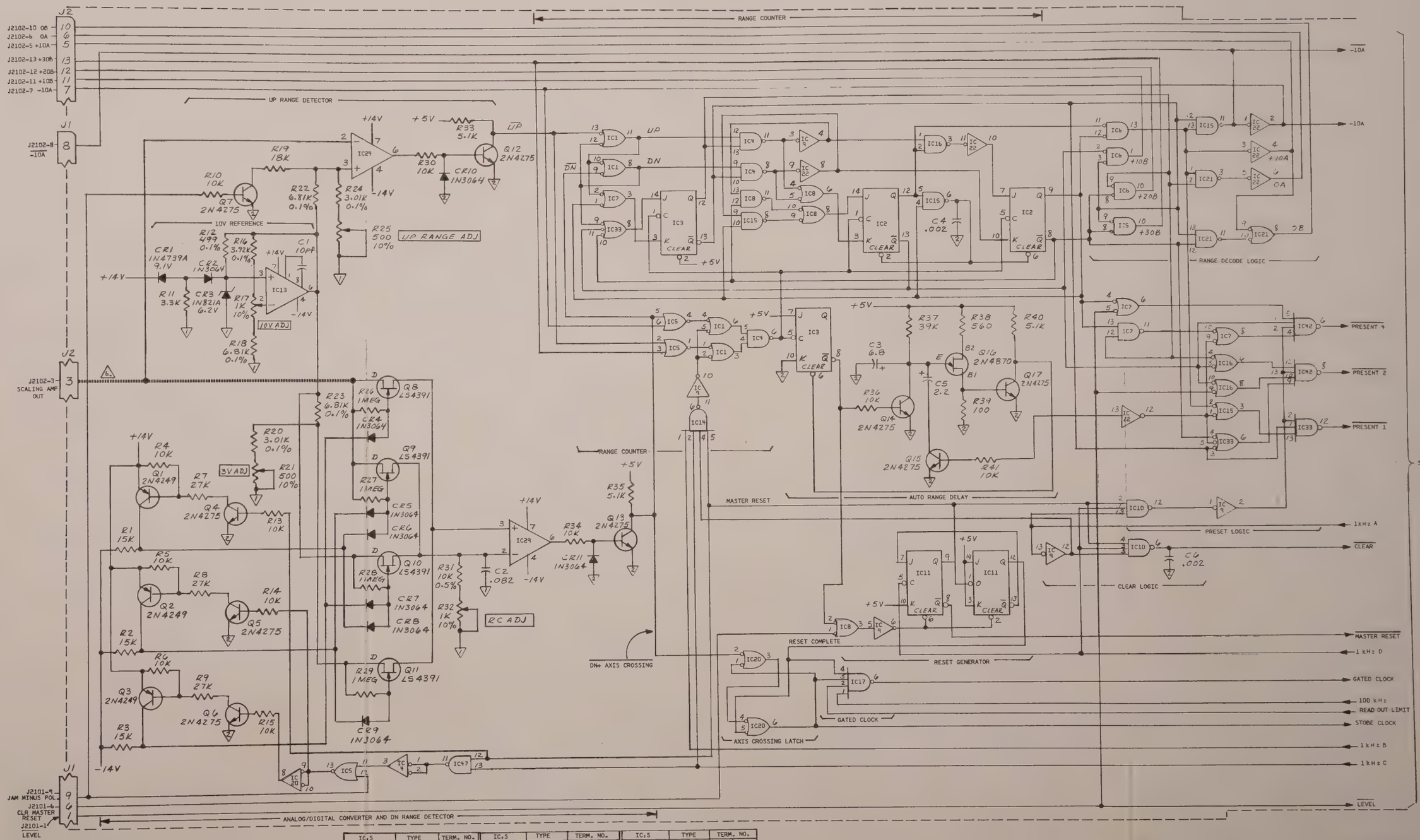


Figure 5. Digital Board. 2300 Sheet 1



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

6A MAIN SIGNAL FLOW

IC,S	TYPE	TERM. NO.	
		VCC	GND
1,4,7,8,15, 16,20,21 32,34,37,43, 44,47,49	SN74L00N	14	7
2,3,11,27,38	SN74L73N	4	11
5,6,48	SN74L02N	14	7
9,22,26	SN74L04N	14	7

IC,S	TYPE	TERM. NO.	
		VCC	GND
10,33	SN74L10N	14	7
19,17,41,42	SN74L20N	14	7
13,24,29	μA748C	7 (+14)	4 (-14)
31,36	SN74L78N	4	11

IC,S	TYPE	TERM. NO.	
		VCC	GND
12,18,19, 23,28,40,46	SN74L93N	4	11
25,30,35, 39,45,50	SN74L74N	14	7
51	SN7447N	16	8
52	LM301A	7 (+14)	4 (-14)

Figure 6. Digital Board. 2300 Sheet 2

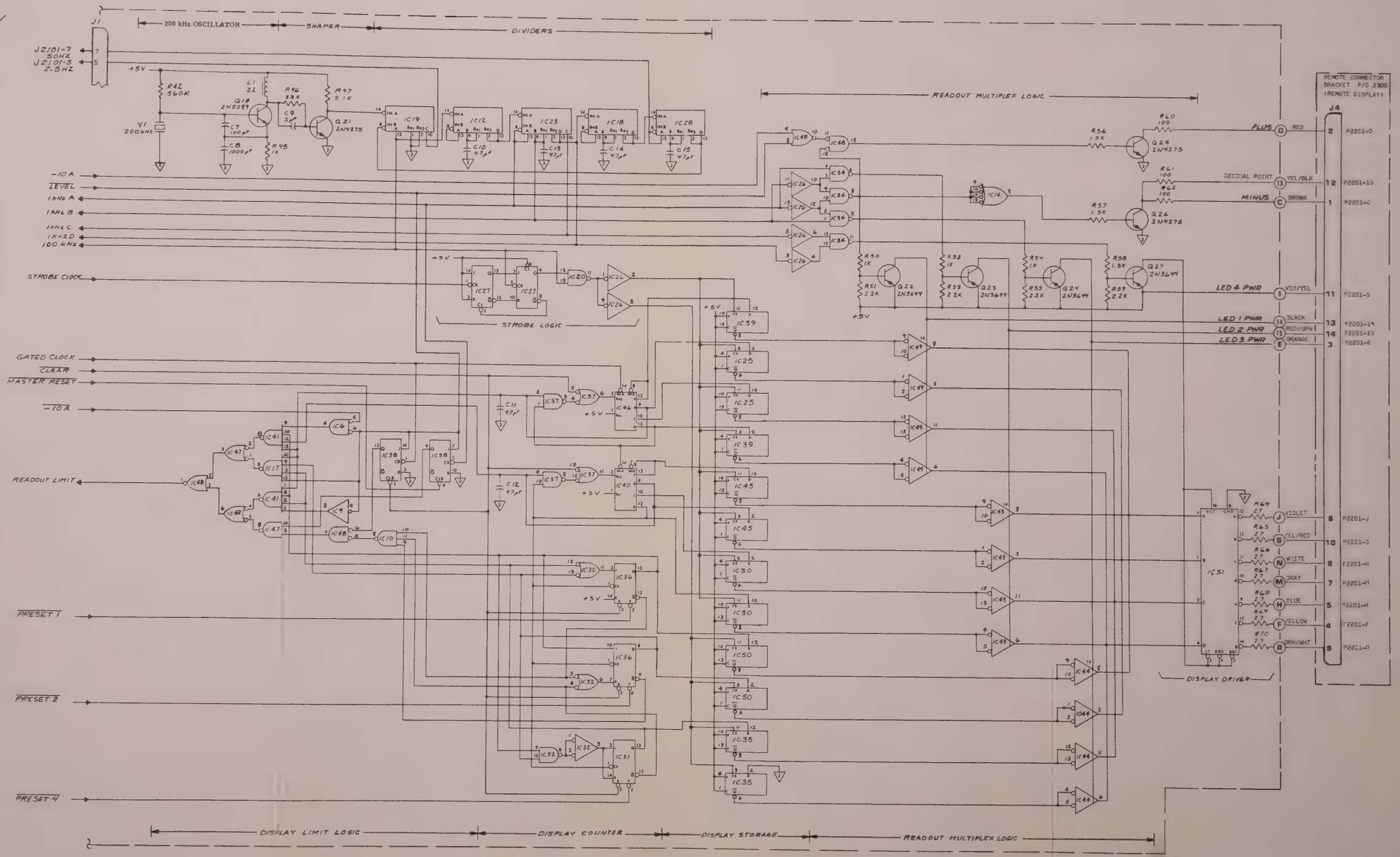


Figure 7. Digital Board. 2300 Sheet 3

DEAR CUSTOMER:

Every effort has been made to ensure the accuracy of this manual. If an error is discovered please notify us on the postpaid cards attached.

Please indicate where the error has been made. To improve future manuals your comments are requested.

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PUBLICATIONS DEPARTMENT

There is an error on page _____/figure _____ of the _____ manual; _____

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